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Casavant

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(54) **INDUCER AND DIFFUSER CONFIGURATION FOR A GAS TURBINE SYSTEM**

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F01D 25/24	(2006.01)
F01D 9/04	(2006.01)

(52) **U.S. Cl.**

CPC ***F04D 29/441*** (2013.01); ***F01D 9/041*** (2013.01); ***F01D 25/24*** (2013.01); *F05D 2240/127* (2013.01)

(58) **Field of Classification Search**

USPC 415/108, 115, 116, 117, 207, 224, 415/224.5; 60/269

See application file for complete search history.

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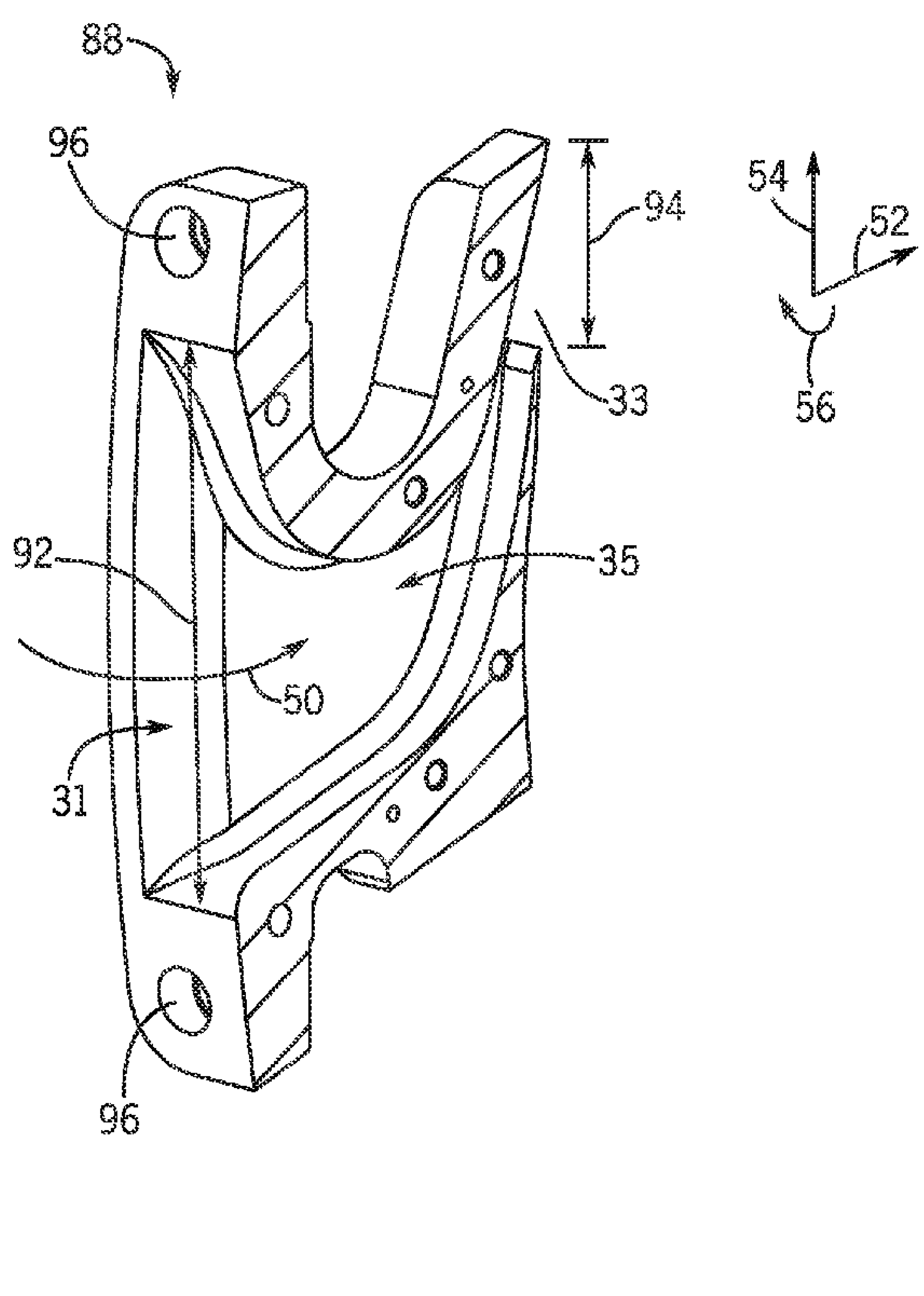
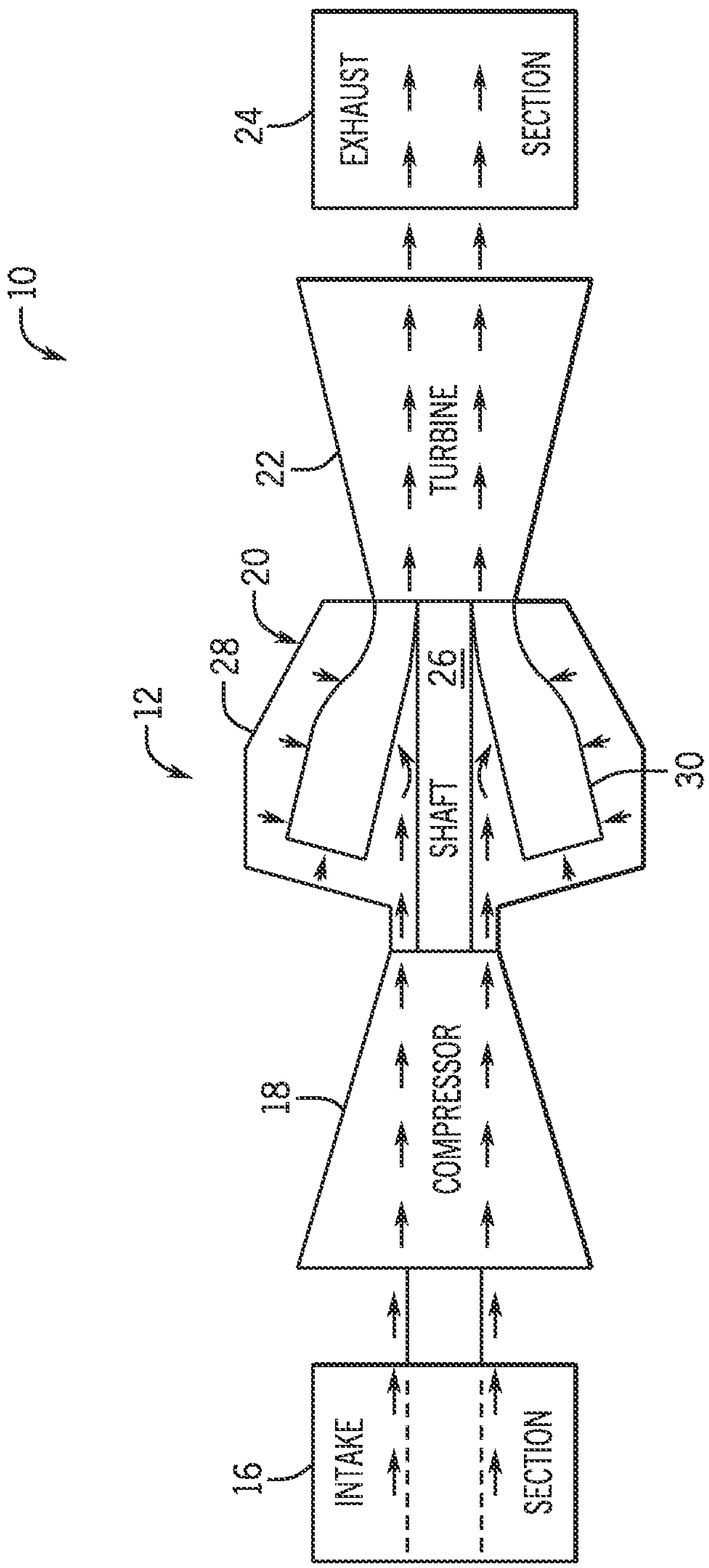
(57) **ABSTRACT**

A system includes at least one inducer including a flow passage configured to guide a fluid flow into a cavity defined by a casing and rotor of a gas turbine engine, the flow passage includes an inlet configured to receive the fluid flow from a compressor diffuser of the gas turbine engine, and an outlet configured to discharge the fluid flow into the cavity. The at least one inducer is configured to be disposed within the gas turbine engine so that the second outlet is axially disposed forward of a diffuser outlet of the compressor diffuser.

15 Claims, 4 Drawing Sheets

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TURBINE
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EXHAUST
SECTION
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SHAFT
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FIG. 1

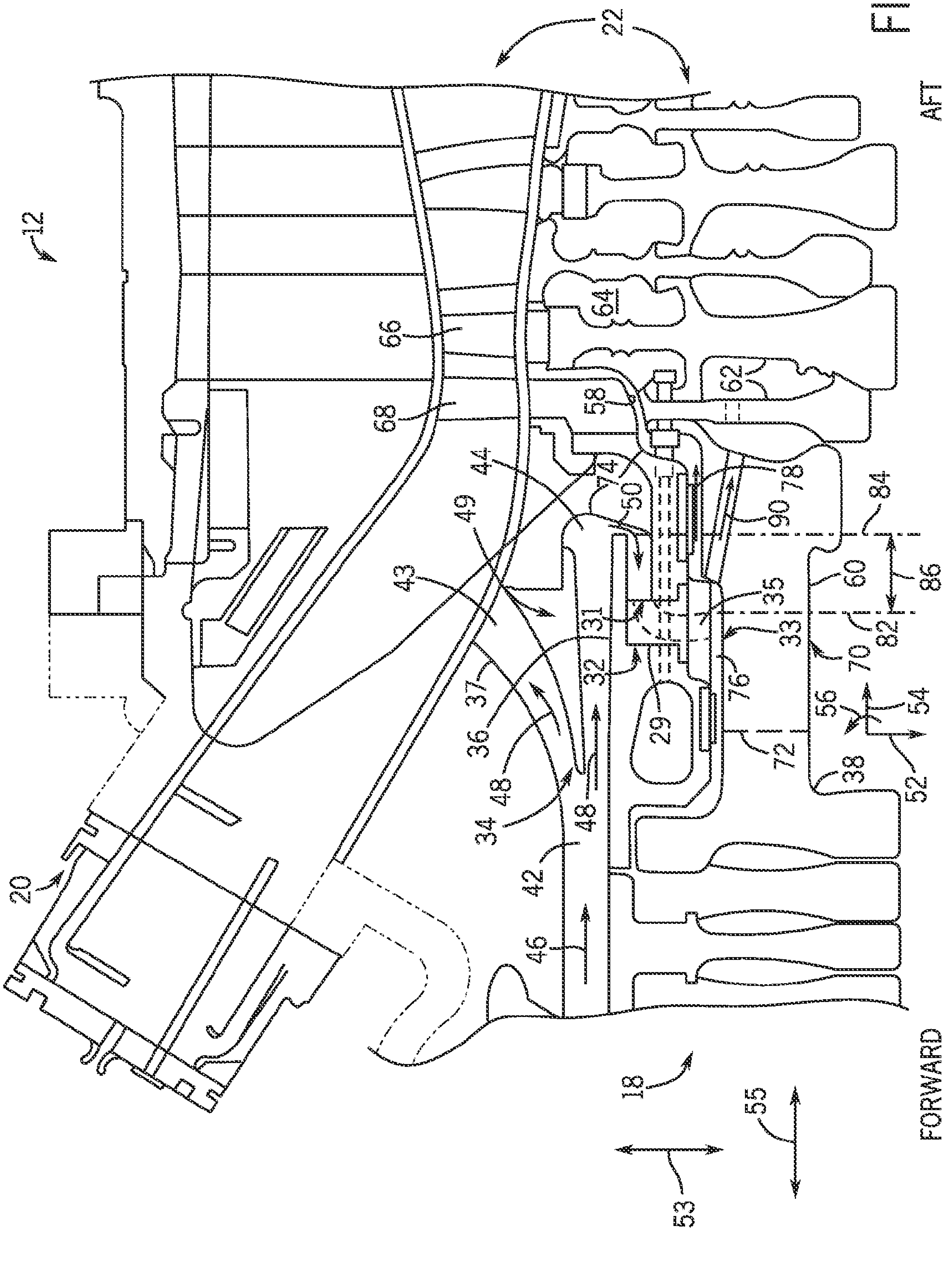
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FIG. 2

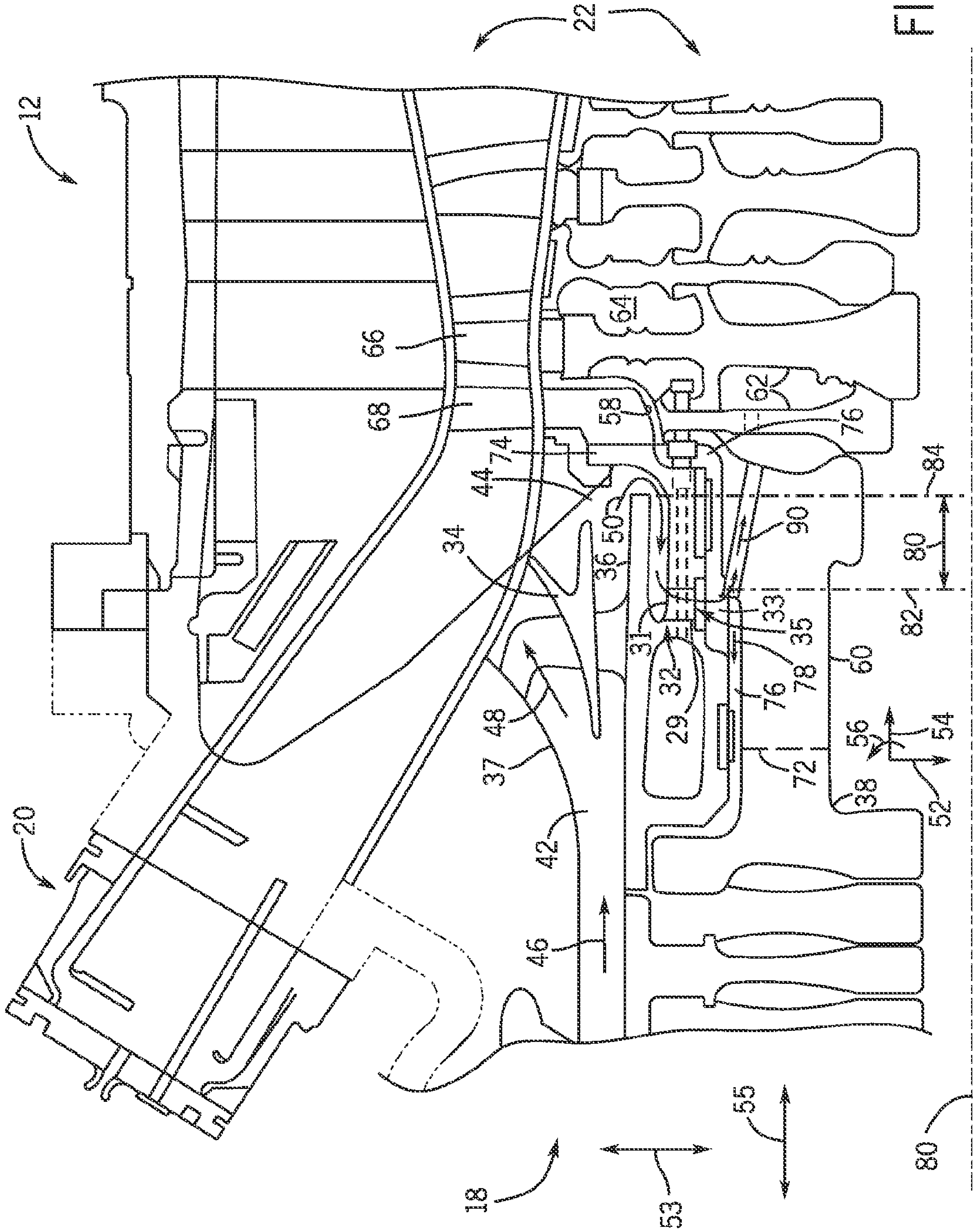
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FIG. 3

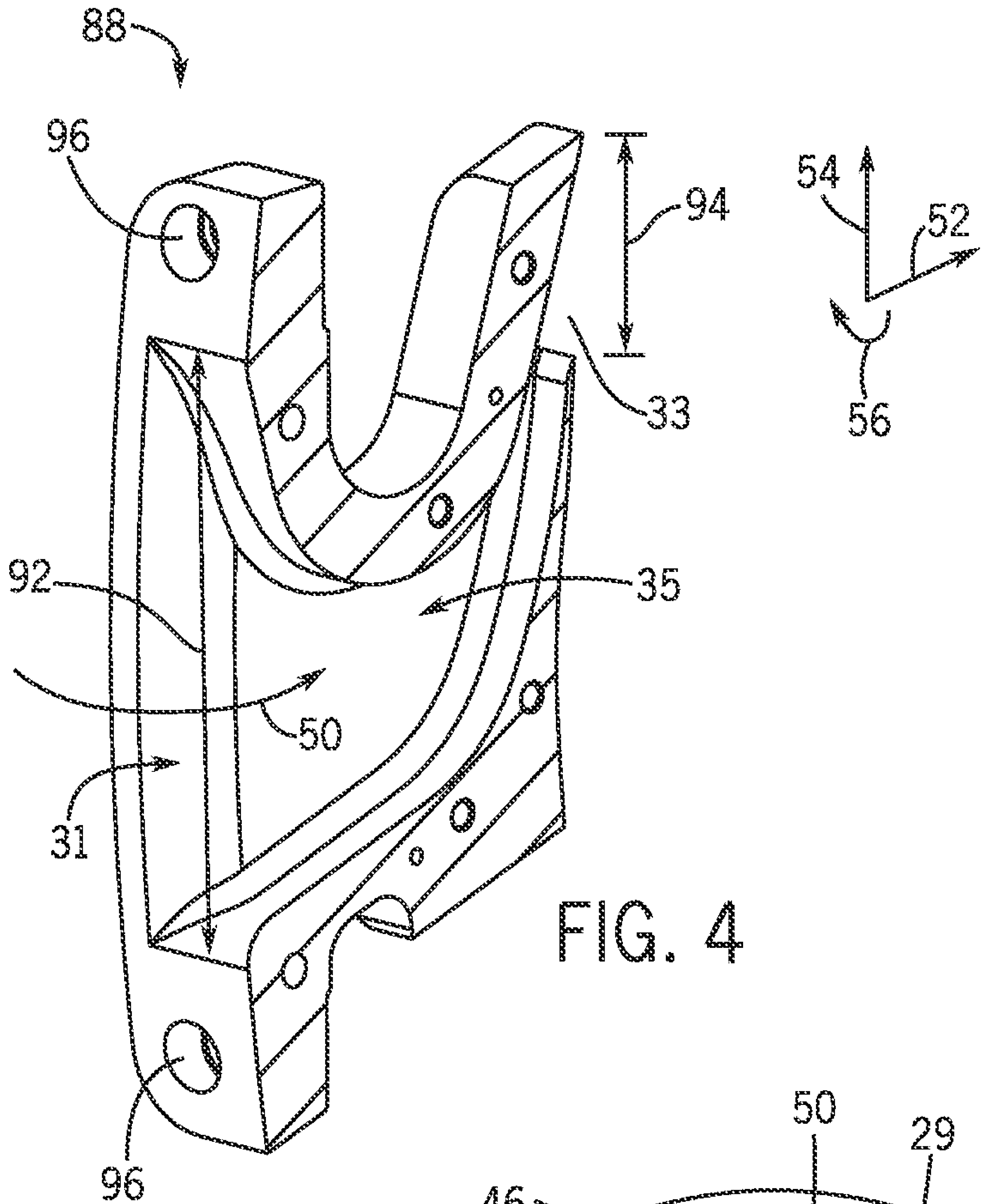
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FIG. 4

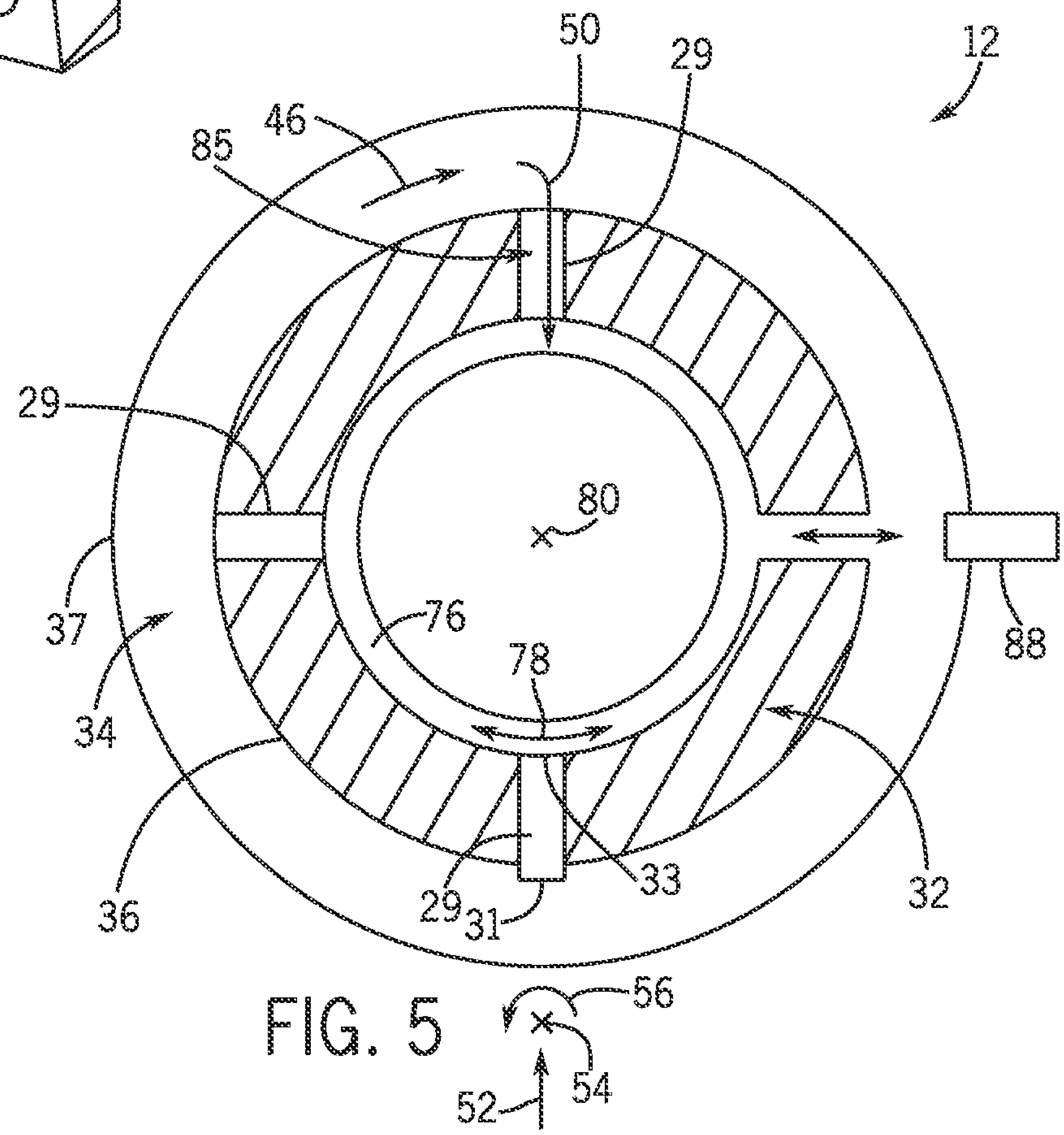
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FIG. 5

INDUCER AND DIFFUSER CONFIGURATION FOR A GAS TURBINE SYSTEM

BACKGROUND

The subject matter disclosed herein relates to gas turbines and, more particularly, to a flow inducer for gas turbines.

Gas turbine engines typically include a number of subsystems, such as compression systems, combustion systems, power turbine systems, and cooling systems. Each subsystem may be helpful in increasing the power output and/or efficiency of the gas turbine engine. Increasing the dimensions of a subsystem, for example, may increase the power output and/or efficiency of that subsystem, and the gas turbine engine as a whole. In certain applications, however, there may be restrictions on the dimensions of the total footprint of the gas turbine. These dimensional restrictions may include the longitudinal length of the gas turbine. As a result of such dimensional restrictions, it may be difficult to increase the power output and/or efficiency of any particular subsystem, much less the entire gas turbine engine.

BRIEF DESCRIPTION

Certain embodiments commensurate in scope with the originally claimed invention are summarized below. These embodiments are not intended to limit the scope of the claimed invention, but rather these embodiments are intended only to provide a brief summary of possible forms of the invention. Indeed, the invention may encompass a variety of forms that may be similar to or different from the embodiments set forth below.

In accordance with a first embodiment, a system includes a gas turbine engine having a compressor, a turbine, a casing, and a rotor. The casing and the rotor are disposed between the compressor and turbine, and the casing and the rotor define a cavity to receive a fluid flow from the compressor. The gas turbine also includes a diffuser disposed aft of the compressor. The diffuser is configured to receive the fluid flow from the compressor, and the diffuser includes a first inlet proximate the compressor and a first outlet distal from the compressor. The gas turbine engine also has an inducer assembly including at least one inducer. The at least one inducer includes a flow passage configured to guide the fluid flow into the cavity, the flow passage includes a second inlet configured to receive the fluid flow and a second outlet configured to discharge the fluid flow into the cavity, and the second outlet is axially disposed forward of the first outlet of the diffuser.

In accordance with a second embodiment, a system includes a gas turbine engine having a compressor, a turbine, a casing, and a rotor. The casing and the rotor are disposed between the compressor and turbine, and the casing and the rotor define a cavity to receive a fluid flow from the compressor. The gas turbine also includes a diffuser disposed aft of the compressor. The diffuser is configured to receive the fluid flow from the compressor, the diffuser is defined by a first wall and a second wall, the first wall being radially disposed more proximate to a longitudinal axis of the gas turbine engine than the second wall, and the diffuser includes a first inlet proximate the compressor and a first outlet distal from the compressor. The gas turbine also has an inducer assembly including at least one inducer. The first wall is disposed between the diffuser and the at least one inducer, the at least one inducer includes a flow passage configured to guide the fluid flow into the cavity. The flow passage includes a second inlet configured to receive the fluid flow and a second outlet configured to discharge the fluid flow into the cavity. The second inlet and the second outlet are radially disposed more proximate to the longitudinal axis of the gas turbine engine than the first wall.

In accordance with a third embodiment, a system includes at least one inducer including a flow passage configured to guide a fluid flow into a cavity defined by a casing and rotor of a gas turbine engine, the flow passage includes an inlet configured to receive the fluid flow from a compressor diffuser of the gas turbine engine, and an outlet configured to discharge the fluid flow into the cavity. The at least one inducer is configured to be disposed within the gas turbine engine so that the second outlet is axially disposed forward of a diffuser outlet of the compressor diffuser.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. **1** is a schematic flow diagram of an embodiment of a gas turbine engine that may employ flow inducers;

FIG. **2** is a partial cross-sectional side view of an embodiment of the gas turbine engine of FIG. **1** that includes an inducer assembly having at least one flow passage or inducer (e.g., axial or radial inducer);

FIG. **3** is a partial cross-sectional side view of an embodiment of the gas turbine engine of FIG. **1** that includes an inducer assembly having at least one flow passage or inducer (e.g., axial-to-radial inducer);

FIG. **4** is a cross-sectional view of an embodiment of an inducer, taken along line **4-4** of FIG. **3**; and

FIG. **5** is a schematic diagram of a cross-sectional view of an embodiment of the gas turbine engine of FIG. **1** that includes an inducer assembly having a plurality of flow passages (e.g., integral and removable inducers).

DETAILED DESCRIPTION

One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

When introducing elements of various embodiments of the present invention, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

The present disclosure is generally directed towards a gas turbine engine with an inducer assembly for providing a cooling flow in a cavity of the gas turbine engine. The inducer directs cooling flow from the compressor of a gas turbine engine to other parts of the engine. Compressed air/gases flow through a diffuser which increases the pressure of the gases before they are mixed with fuel and combusted in the combustor. The inducer diverts a portion of the compressed air before it is combusted as a cooling flow. Rather than simply fitting the inducer at the end of the diffuser, the inducer is packaged in such a way that it is forward of an exit of a diffuser flowpath. Thus, air exiting the diffuser is directed back toward the compressor section of the gas turbine before flowing through the inducer into the cooling paths throughout the rest of the engine.

FIG. **1** is a block diagram of a system **10** that includes a gas turbine engine **12** that may employ one or more inducers (e.g., inducer assembly) configured to direct cooling fluid to a cavity within the gas turbine engine **12**, as described in detail below. In certain embodiments, the system **10** may include an aircraft, a watercraft, a locomotive, a power generation system, or combinations thereof. The illustrated gas turbine engine **12** includes an air intake section **16**, a compressor **18**, a combustor section **20**, a turbine **22**, and an exhaust section **24**. The turbine **22** is coupled to the compressor **18** via a shaft **26**.

As indicated by the arrows, air may enter the gas turbine engine **12** through the intake section **16** and flow into the compressor **18**, which compresses the air prior to entry into the combustor section **20**. The illustrated combustor section **20** includes a combustor housing **28** disposed concentrically or annularly about the shaft **26** between the compressor **18** and the turbine **22**. The compressed air from the compressor **18** enters combustors **30**, where the compressed air may mix and combust with fuel within the combustors **30** to drive the turbine **22**.

From the combustor section **20**, the hot combustion gases flow through the turbine **22**, thereby driving the compressor **18** via the shaft **26**. For example, the combustion gases may apply motive forces to turbine rotor blades within the turbine **22** to rotate the shaft **26**. After flowing through the turbine **22**, the hot combustion gases may exit the gas turbine engine **12** through the exhaust section **24**. As discussed below, the turbine **22** may include one or more inducers **29** forward of a diffuser **34** (e.g., compressor diffuser region **34**). The diffuser **34** may diffuse the gas that has been compressed by the compressor **18**, which increases the pressure and prepares the gas to flow to the combustor **30** and be mixed with fuel and combusted. The diffuser **34** may also direct cooling fluid to cool the shaft **26** and the turbine **22**. Placing the one or more inducers **29** forward of the diffuser **34** enables the overall length and width of the gas turbine engine **12** to be shortened (e.g., longitudinally and radially), allowing the system **10** to operate in a smaller space.

FIG. **2** is a partial cross-sectional side view of an embodiment of a portion of the gas turbine engine **12** having a fluid flow inducer assembly **32** having one or more inducers **29** (e.g., axial or radial inducer) for routing cooling fluid flow (e.g., air flow) toward the turbine section **22** of the engine **12**. Although discussed in relation to a gas turbine engine **12**, the inducer assembly **32** or its inducers **29** may be used in other applications. As described above, the gas turbine engine **12** includes the compressor **18**, the combustor section **20**, and the turbine **22**. The compressor **18** and the turbine **18** are coupled together by the rotor as described below. The compressor **18** includes a first wall **36**, a portion of which may be known as a compressor discharge casing or compressor stator component, and an inner rotor component **38** (e.g., compressor rotor). A diffuser **34** at least partially defined by the first wall **36** and a second wall **37**, which may also be known as an outer casing, is located aft or downstream of the compressor **18**. The first wall **36** defines the inner boundary of the diffuser **34**, meaning that the first wall **36** defines a boundary that is closer to a longitudinal axis **80** than the second wall **37**. The illustrated first wall **36** may be generally straight (e.g., parallel to the axis **80**), such that the first wall **36** has a cylindrical or annular shape. The second wall **37** defines the outer boundary of the diffuser **34**. The second wall **37** diverges from the longitudinal axis **80** as it moves in the axial direction **54**, such that the second wall **37** has a diverging annular shape. The shape of either the first wall **36** or the second wall **37** may be different than shown in FIG. **2**. For instance, the first wall **36** may be angled in the radial direction **52** (e.g., converging toward or diverging away from the longitudinal axis **80**) as it moves in the axial direction **54**. Also, the second wall **37** may include a cylindrical shape. However, in certain embodiment, the first and second walls **36** and **37** of the diffuser **34** may generally diverge from one another in the downstream axial direction **54**, thereby causing diffusion of the compressed air flow in the axial and/or radial directions **54** and **52**. Thus, the first and second walls **36** and **37** of the diffuser **34** may generally define an expanding annular passage.

The diffuser **34** includes an inlet **42** (e.g., annular opening or passage) proximate the compressor **18**, and a first outlet **43** (e.g., annular opening or passage) and a second outlet **44** (e.g., annular opening or passage) at the distal end of the diffuser **34**, away from the compressor **18**. A fluid (e.g., air and/or another gas), referred to as a fluid flow **46**, travels through and is pressurized within the compressor **18**. The diffuser **34** guides a portion of the fluid flow **46** in a longitudinal direction **54** and slightly away from a radial direction **52** along a passage **48** (e.g., annular passage) adjacent the second wall **37** and through the first outlet **43** to the combustors **20**. In addition, the diffuser **34** guides another portion **50** of the fluid flow **46** in the longitudinal direction **54** along a passage **48** (e.g., annular passage) adjacent to the first wall **36**. As illustrated, the passages **48** may be separated from one another by a divider or spreader **49** (e.g., an annular spreader) disposed between the walls **36** and **37** in a coaxial arrangement. The spreader **49** may diverge in the downstream axial direction **54**, thereby helping to guide the fluid flows along the walls **36** and **37**. Again, the first fluid flow (e.g., air) flows along the wall **37** at an angle radially away from the axis **80**, while the second fluid flow (e.g., air) flows along the axis **80**. Afterwards, the fluid flow portion **50** passes through the second outlet **44** in an inward radial direction **52** toward the axis **80**, and then in an upstream axial direction opposite the downstream axial direction **54** towards the inducer assembly **32**.

The turbine **22** includes a turbine stator component **58** and an inner rotor component **60** (e.g., turbine rotor). The rotor component **60** may be joined to one or more turbine wheels **62** disposed in a turbine wheel space **64**. Various turbine rotor blades **66** are mounted to the turbine wheels **62**, while turbine stator vanes or blades **68** are disposed in fixed positions in the turbine **22**. The rotor blades **66** and the stator blades **68** form turbine stages. The adjoining ends of the compressor rotor **38** and the turbine rotor **60** may be joined (e.g., bolted together) to each other to form an inner rotary component or rotor **70**. A rotor joint **72** may join the adjoining ends of the rotors **38**, **60**. The adjoining ends of the first wall **36** and the turbine stator component **58** may be coupled to each other (e.g., bolted together) to form an outer stationary casing **74** surrounding the rotor **70**. In certain embodiments, the first wall **36** and the turbine stator component **58** form a singular component without using flanges or joints to form the casing **74**. Thus, the components of the compressor **18** and the turbine **22** define the rotor **70** and the casing **74**. As illustrated, the compressor and turbine components define a cavity **76** (e.g., annular cavity). However, depending on the location of the inducer assembly **32** or inducers **29**, the cavity **76** may be defined solely by turbine components. For example, the inducer assembly **32** or inducer **29** may be disposed between turbine stages.

In the disclosed embodiments, the inducer assembly **32** facilitates cooling of the wheel space **64** and/or rotor joint **72**. The inducer **29** may be any type of inducer, including integrated inducers formed as a hole or passage in the casing **74**. The inducer **29** may also include modular inducers that are formed to fit within the casing **74** and configured to be removed or replaced during servicing operations. In particular, in order to cool the turbine **22** and/or other parts of the gas turbine engine **12**, the inducer **29** receives a portion **50** of the fluid flow **46** from the compressor **18** through an inducer inlet **31**. The inducer inlet **31** may be adjacent to the distal end of the first wall **36** or may be further away from the end of the first wall **36** as shown in FIG. **2**. Thus, the fluid flow portion **50** may flow around the first wall **52** in the radial direction **52** and then back in an upstream axial direction opposite the downstream axial direction **54** before entering the inducer inlet **31**. Thus, the inducer **29** may be characterized as being underneath (e.g., radially inward from) the first wall **36**. Following the inducer inlet **31**, the fluid flow portion **50** leads through a flow passage **35** defined by inner boundaries of the inducer **29**. The flow passage **35**, as illustrated, directs the fluid flow portion **50** generally in the radial direction **52**. The fluid then exits the inducer assembly **32** through the inducer outlet **33** and directs the fluid flow portion **50** into the cavity **76** to generate a cavity fluid flow **78**. The inducer outlet **33** may be positioned at a first longitudinal location **82** along the longitudinal axis of rotation **80**. The outlet **44** of the diffuser **34**, meanwhile, may be positioned at a second longitudinal location **84**, such as the illustrated position at the end of the first wall **36**. The position of the inducer **29** may be underneath the first wall **36** in the radial direction **52**.

As shown in FIG. **2**, the first longitudinal location **82** may be forward (i.e., upstream of) the second longitudinal location **84**. That is, the first longitudinal location **82** may be axially closer to the compressor **18** and axially further from the turbine **22**. An overlap distance **86** shows the axial distance that the inducer assembly **32** is forward of the outlet **44** (i.e., the axial distance between the first **82** and second **84** longitudinal locations). The overlap distance **86** is not restricted only to the distance discernible from FIG. **2**. The overlap distance **86** between the locations (i.e., first longitudinal location **82** and second longitudinal location **84**) may be any distance suitable for a particular gas turbine engine **12**. For example, the overlap distance **86** may be zero, whereby the inducer inlet **31** is axially aligned with the diffuser outlet **44** and the inlet **31** is axially aligned with the distal end of the first wall **36**. However, in the illustrated embodiment, the inducer outlet **33** is positioned forward (i.e., axially upstream) of the diffuser outlet **44** to enable the inducer assembly **32** and diffuser **34** to occupy less longitudinal length **55**. Additionally, the placement of the inducer assembly **32** underneath (e.g., radially inward from) the first wall **36** may enable the gas turbine engine **12** to occupy less radial **52** space, which reduces the height **53** of the inducer assembly **32** and/or the diffuser **34**. Reducing the height **53** and length **55** of these sections (e.g., inducer assembly **32** and diffuser **34**) of the gas turbine engine **12** enables the overall height and length of the gas turbine engine **12** to be reduced as well. Alternatively, the overall length of the gas turbine engine **12** may, of course, remain constant while the reduction in length of the diffuser/inducer is taken up by a proportional increase in the length of other sections of the gas turbine engine (e.g., intake **16**, compressor **18**, turbine **22**, exhaust **24**). Thus, the power output/unit length of the gas turbine engine **12** may be increased with the disclosed embodiment of the diffuser **34** and inducer assembly **32**.

In certain embodiments, the inducer assembly **32** may receive the fluid flow portion **50** from a source (e.g., fluid flow source) external to the gas turbine **10** (e.g., waste fluid from an IGCC system). In addition, the inducer **29** directs the fluid flow portion **50** (e.g., inducer fluid flow) in a substantially circumferential direction **56** to swirl around the longitudinal axis **80** (e.g., rotational axis) of the gas turbine engine **12** to merge with the cavity fluid flow **78** to form a cooling medium **90** (e.g., cooling fluid flow). The cooling fluid flow **90** and/or the cavity fluid flow **78** may be directed toward the wheel space **64** and/or the rotor joint **72**. In particular, a portion of the cooling fluid flow **90** may flow through the cavity **76** to interact with and cool the wheel space **64** and/or the rotor joint **72**.

FIG. **3** is a partial cross-sectional side view of an embodiment of a portion of the gas turbine engine **12** having the fluid flow inducer assembly **32** having one or more inducers **29** (e.g., axial-to-radial inducers) for routing cooling fluid flow (e.g., air flow) toward the turbine section **22** of the engine **12**. Although discussed in relation to the gas turbine engine **12**, the inducer assembly **32** or the inducers **29** may be used in other applications. As with the embodiment described above in FIG. **2**, the gas turbine engine **12** includes the compressor **18**, the combustor section **20**, and the turbine **22**. The compressor **18** includes a first wall **36**, a portion of which may be known as a compressor discharge casing or compressor stator component, and an inner rotor component **38** (e.g., compressor rotor). A diffuser **34** at least partially defined by the first wall **36** and a second wall **37**, which may also be known as an outer casing, is located aft or downstream of the compressor **18**. The first wall **36** defines the inner boundary of the diffuser **34**, meaning that the first wall **36** defines a boundary that it closer to a longitudinal axis **80** than the second wall **37**. The illustrated first wall **36** may be generally straight (e.g., parallel to the axis **80**), such that the first wall **36** has a cylindrical or annular shape. The second wall **37** defines the outer boundary of the diffuser **34**. The second wall **37** diverges from the longitudinal axis **80** as it moves in the axial direction **54** such that the second wall **37** has a diverging annular shape. The shape of either the first wall **36** or the second wall **37** may be different than shown in FIG. **2**. For instance, the first wall **36** be angled in the radial direction **52** (e.g., converging toward or diverging away from the longitudinal axis **80**) as it moves in the axial direction **54**. Also, the second wall **37** may include a cylindrical shape. However, in certain embodiment, the first and second walls **36** and **37** of the diffuser **34** may generally diverge from one another in the downstream axial direction **54**, thereby causing diffusion of the compressed air flow in the axial and/or radial directions **54** and **52**. Thus, the first and second walls **36** and **37** of the diffuser **34** may generally define an expanding annular passage.

As in FIG. **2**, the gas turbine engine **12** of FIG. **3** includes various components for the turbine **22**, such as wheels **62** and blades **66**, **68**. The adjoining ends of the compressor rotor **38** and the turbine rotor **60** may be joined (e.g., bolted together) to each other to form an inner rotary component or rotor **70**. The rotor joint **72** may join the adjoining ends of the rotors **38**, **60**. The adjoining ends of the first wall **36** and the turbine stator component **58** may be coupled to each other (e.g., bolted together) to form the outer stationary casing **74** surrounding the rotor **70**. In certain embodiments, the first wall **36** and the turbine stator component **58** form a singular component without using flanges or joints to form the casing **74**. Thus, the components of the compressor **18** and the turbine **22** define the rotor **70** and the casing **74**. As illustrated, the compressor and turbine components define the cavity **76** (e.g., annular cavity). However, depending on the location of the inducer assembly **32** or inducers **29**, the cavity **76** may be defined solely by turbine components. For example, the inducer assembly **32** or inducer **29** may be disposed between turbine stages.

In the disclosed embodiments, the inducer assembly **32** facilitates cooling of the wheel space **64** and/or rotor joint **72**. The inducer **29** may again be any type of inducer, including integrated inducers formed as a hole or passage in the casing **74**. The inducer **29** may also include modular inducers that are formed to fit within the casing **74** and configured to be removed or replaced during servicing operations. In particular, the inducer assembly **32** receives a portion **50** of the fluid flow **46** from the compressor **18** via the diffuser **34** through an inducer inlet **31**. The inducer assembly **32** directs the fluid flow portion **50** in a generally radial **52**-to-axial **54** direction. This is explained further in the description related to FIG. **4**. As described above with regard to FIG. **2**, the gas turbine engine **12** forms a cavity **76** between the casing **74** and the rotor **70** during operation. The inducer outlet **33** may be positioned at a first longitudinal location **82** along the longitudinal axis of rotation **80**. The outlet **44** of the diffuser **34**, meanwhile, may be positioned at a second longitudinal location **84** at the distal end of the first wall **36**, such as the illustrated position at the end of the first wall **36**. The position of the inducer **29** (i.e., inducer inlet **31** and inducer outlet **33**) may be underneath the first wall **36** in the radial direction **52**.

Like the embodiment shown in FIG. **2**, the first longitudinal location **82** may be forward (i.e., upstream of) the second longitudinal location **84**. That is, the first longitudinal location **82** may be axially closer to the compressor **18** and axially further from the turbine **22**. An overlap distance **86** shows the axial distance that the inducer assembly **32** is forward of the outlet **44** (i.e., the axial distance between the first **82** and second **84** longitudinal locations). The overlap distance **86** is not restricted only to the distance discernible from FIG. **2**. The overlap distance **86** between the locations (i.e., first longitudinal location **82** and second longitudinal location **84**) may be any distance suitable for a particular gas turbine engine **12**. For example, the overlap distance **86** may be zero, whereby the inducer inlet **31** is axially aligned with the diffuser outlet **44**. Having the inducer outlet **33** forward of the diffuser outlet **44** enables the inducer assembly **32** and diffuser **34** to occupy less longitudinal length. Additionally, the placement of the inducer assembly **32** underneath (e.g., radially inward from) the first wall **36** may enable the gas turbine engine **12** to occupy less radial **52** space, which reduces the height of the inducer assembly **32** and/or the diffuser **34**. Reducing the height and length of these sections (e.g., inducer assembly **32** and diffuser **34**) of the gas turbine engine **12** enables the overall height and length of the gas turbine engine **12** to be reduced as well. Alternatively, the overall length of the gas turbine engine **12** may, of course, remain constant while the reduction in length of the diffuser/inducer is taken up by a proportional increase in the length of other sections of the gas turbine engine (e.g., intake **16**, compressor **18**, turbine **22**, exhaust **24**). Thus, the power output/unit length of the gas turbine engine **12** may be increased with the disclosed embodiments of the diffuser **34** and inducer assembly **32**.

In certain embodiments, the inducer assembly **32** may receive the fluid flow portion **50** from a source (e.g., fluid flow source) external to the gas turbine **10** (e.g., waste fluid from an IGCC system). In addition, the inducer **29** directs the fluid flow portion **50** (e.g., inducer fluid flow) in a substantially circumferential direction **56** to swirl around the longitudinal axis **80** (e.g., rotational axis) of the gas turbine engine **12** to merge with the cavity fluid flow **78** to form a cooling medium **90** (e.g., cooling fluid flow). The cooling fluid flow **90** and/or the cavity fluid flow **78** may be directed toward the wheel space **64** and/or the rotor joint **72**. In particular, a portion of the cooling fluid flow **90** may flow through the cavity **76** to interact with and cool the wheel space **64** and/or the rotor joint **72**.

FIG. **4** is a cross-sectional view of an embodiment of an inducer **88** of the inducer assembly **32**. The inducer **88** shown in FIG. **4** may be a modular inducer that is configured to be removable from the casing **74** when the engine **12** is not in operation. For example, during service operation, the casing **74** may be separated from the rotor **70**, facilitating access to the inducer **88** and the inducer assembly **32**. The inducer **88** may be installed using attachment means secured through the bolt holes **96**. The inducer **88** includes the inlet **31** and the outlet **33** shown in FIGS. **2** and **3**. The inducer **88** guides the fluid flow portion **50** through the flow passage **35** toward the cavity **76**, as described above. The fluid flow portion **50** then exits the inducer assembly **32** through the inducer outlet **33** and directs the fluid flow portion **50** into the cavity **76** to generate the cavity fluid flow **78**. The illustrated inducer **88** demonstrates a radial-to-axial inducer. That is, the fluid flow **50** flows first in a radial direction **52** but is then directed by the flow passage **35** in the axial direction **54**. Other inducers **88** may be includes that have a flow passage **35** that directs the fluid flow **50** in the radial direction **52** or in the axial direction **54** only. Also as illustrated, the inducer **88** may include an inlet width **92** that is greater than an outlet width **94**. The difference in widths (e.g., inlet width **92** and outlet width **94**) may enable the fluid flow **50** to increase in velocity as it exits the outlet **33** and enters into the cavity **76**. An increase in fluid flow velocity may provide more convective cooling fluid flow which results in faster cooling to the turbine section **22** as the fluid flow **50** would reach the turbine section **22** more quickly. Also, some embodiments may also include inducers **88** that provide a circumferential **56** turn, which induces a swirl in the same direction that the rotor **70** rotates. This circumferential **56** swirl enables less drag on the rotor **70** as it rotates around the longitudinal axis **80**.

FIG. **5** is a schematic diagram of an embodiment of the gas turbine engine **12** of FIG. **1** that includes the diffuser **34** and the inducer assembly **32** having a plurality of flow passages **35** (e.g., modular inducers **88**). As illustrated, the diffuser **34** includes the first wall **36** axially closer to the longitudinal axis **80** and the second wall **37** axially further from the longitudinal axis **80**. Also as illustrated, the inducer assembly **32** includes four inducers **29**, **88** spaced circumferentially about the axis **80**. Other embodiments may include more or fewer inducers **29**, **88**. For example, the inducer assembly **32** may include 1, 2, 3, 10, 25, or more inducers **29**, **88**. Each inducer **29** may include the inlet (e.g., inlet **31**) and the outlet (e.g., outlet **33**). As illustrated, the inducers **29**, **88** may be modular inducer cartridges. The modular inducer cartridges may be removable as demonstrated by inducer **88**, which is shown partially removed from the inducer assembly **32**. The inducers **29** may enable the fluid flow **46** to flow through the inducer flow passage **35** to the cavity **76**. The inducers **29**, **88** may be installed forward of an outlet **44** to the diffuser **34**, which allows the diffuser **34** and/or the inducer assembly **32** to take up less space longitudinally **54** and/or radially **52**.

Technical effects of the disclosed embodiments include providing an inducer assembly **32** having one or more inducers **29**, **88** (e.g., axial, axial-to-radial, or radial inducers) for the gas turbine engine **12**. In particular, the inducer assembly **32** may enable an increase in the overall efficiency of the gas turbine engine **12** by minimizing the longitudinal length of the diffuser **34** and inducer assembly **32** sections of the gas turbine engine **12**. The inducer assembly **32** is disposed axially forward of the outlet **44** of the diffuser **34** and may include one or more inducers **29**, **88**. The shorter length of the diffuser **34** and inducer assembly **32** sections may enable other sections of the gas turbine engine **12** to increase in size and power generation, or may enable the gas turbine engine **12** to fit into areas with smaller size restrictions.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

The invention claimed is:

1. A system comprising:

a gas turbine engine comprising:

a compressor;

a turbine;

a casing;

a rotor, wherein the casing and the rotor are disposed between the compressor and turbine, and the casing and the rotor define a cavity to receive a fluid flow from the compressor;

a diffuser disposed aft of the compressor, wherein the diffuser is configured to receive the fluid flow from the compressor, and the diffuser comprises a first inlet proximate the compressor and a first outlet distal from the compressor; and

an inducer assembly comprising at least one inducer, wherein the at least one inducer comprises a flow passage configured to guide the fluid flow into the cavity, the flow passage comprises a second inlet configured to receive the fluid flow and a second outlet configured to discharge the fluid flow directly into the cavity, and both the second inlet and the second outlet are axially disposed forward of the first outlet of the diffuser.

2. The system of claim **1**, wherein the diffuser is defined by a first wall and a second wall, wherein the first wall is radially disposed more proximate to a longitudinal axis of the gas turbine engine than the second wall, and the first wall is disposed between the diffuser and the at least one inducer.

3. The system of claim **2**, wherein the second inlet and the second outlet of the at least one inducer are disposed radially inward from the first wall toward the longitudinal axis of the gas turbine engine.

4. The system of claim **2**, wherein the second outlet of the at least one inducer is axially disposed forward of a distal end of the first wall, wherein the distal end of the first wall is adjacent the first outlet.

5. The system of claim **4**, wherein the second inlet of the at least one inducer is axially disposed forward of the distal end of the first wall.

6. The system of claim **2**, wherein the second inlet and the second outlet of the at least one inducer are disposed radially between the first wall and the longitudinal axis of the gas turbine engine.

7. The system of claim **1**, wherein the at least one inducer comprises an axial inducer, an axial-to-radial diffuser, a radial diffuser, a radial-to-axial inducer, or any combination thereof.

8. The system of claim **1**, wherein the at least one inducer is integral to the inducer assembly or removable from the inducer assembly.

9. A system comprising:

a gas turbine engine comprising:

a compressor;

a turbine;

a casing;

a rotor, wherein the casing and the rotor are disposed between the compressor and turbine, and the casing and the rotor define a cavity to receive a fluid flow from the compressor;

a diffuser disposed aft of the compressor, wherein the diffuser is configured to receive the fluid flow from the compressor, the diffuser is defined by a first wall and a second wall, the first wall being radially disposed more proximate to a longitudinal axis of the gas turbine engine than the second wall, and the diffuser comprises a first inlet proximate the compressor and a first outlet distal from the compressor; and

an inducer assembly comprising at least one inducer, wherein the first wall is disposed between the diffuser and the at least one inducer, and wherein the at least one inducer comprises a flow passage configured to guide the fluid flow into the cavity, the flow passage comprises a second inlet configured to receive the fluid flow and a second outlet configured to discharge the fluid flow directly into the cavity, the second inlet and the second outlet are radially disposed more proximate to the longitudinal axis of the gas turbine engine than the first wall, and both the second inlet and the second outlet are axially disposed forward of the first outlet of the diffuser.

10. The system of claim **9**, wherein the second outlet of the at least one inducer is axially disposed forward of a distal end of the first wall, wherein the distal end of the first wall is adjacent the first outlet.

11. The system of claim **10**, wherein the second inlet of the at least one inducer is axially disposed forward of the distal end of the first wall.

12. The system of claim **9**, wherein the second inlet and the second outlet of the at least one inducer are disposed radially inward from the first wall toward the longitudinal axis of the gas turbine engine.

13. A system comprising:

at least one inducer comprising a flow passage configured to guide a fluid flow into a cavity defined by a casing and rotor of a gas turbine engine, the flow passage comprises an inlet configured to receive the fluid flow from a compressor diffuser of the gas turbine engine, and an outlet configured to discharge the fluid flow directly into the cavity, wherein the at least one inducer is configured to be disposed within the gas turbine engine so that both the second inlet and the second outlet are axially disposed forward of a diffuser outlet of the compressor diffuser.

14. The system of claim **2**, wherein the first wall comprises a first surface that interfaces with the cooling flow within the diffuser, a second surface disposed opposite the first surface, and a distal end of the first wall adjacent the first outlet, and wherein the gas turbine engine comprises a flow path for the fluid flow from the diffuser to the at least one inducer, and the flow path proceeds along a first surface of the first wall in a downstream direction, turns about the distal end in a radial direction, and proceeds along the second surface of the first wall towards the second inlet in an upstream direction.

15. The system of claim **9**, wherein the first wall comprises a first surface that interfaces with the cooling flow within the diffuser, a second surface disposed opposite the first surface, and a distal end of the first wall adjacent the first outlet, and wherein the gas turbine engine comprises a flow path for the fluid flow from the diffuser to the at least one inducer, and the flow path proceeds along a first surface of the first wall in a downstream direction, turns about the distal end in a radial direction, and proceeds along the second surface of the first wall towards the second inlet in an upstream direction.

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